93學年度國立成功大學 電機工程學系 甲組 電子材料概論 試題 共 1 頁 第 1 頁

1. Explain the following terms. (30%)
   (a) Ionic bonding (b) Diffusion (c) Frenkel defect (d) Dislocation
   (e) Complex relative permittivity (f) Piezoelectric effect

2. Calculate the planar density of atoms on the (1 0 0) and (1 1 0) in a BCC structure. (10%)

3. Draw the structure and calculate the density of CsCl, where the atomic weights of Cs and Cl are 132.9 g/mol and 35.45 g/mol, respectively, and their radii are given as $r(Cs^+)$=0.167 nm, $R(Cl^-)$=0.181 nm. (20%)

4. Consider a nonpolarized 100 nF capacitor design at 60 Hz operation. Note that there are three candidate dielectrics, as listed in Table 1. (20%)
   a. Calculate the volume of the 100 nF capacitor for each dielectric, given that they are to be used under low voltages and each dielectric has its minimum fabrication thickness. Which one has the smallest volume?
   b. How is the volume affected if the capacitor is to be used at a 500 V application and the maximum field in the dielectric must be a factor of 2 less than the dielectric strength? Which one has the smallest volume?
   c. At a 500 V application, what is the power dissipated in each capacitor at 60 Hz operation? Which one has the lowest dissipation?

Table 1 Comparison of dielectric properties at 60 Hz (typical values)

	Polymer Film PET	**Ceramic TiO_2**	**High-*K* Ceramic ($BaTiO_3$ based)**
Name	Polyester	Polycrystalline titania	X7R
ε_r'	3.2	90	1800
tan δ	5×10^{-3}	4×10^{-4}	5×10^{-2}
$\mathcal{E}_{br}$ (kV cm^{-1})	150	50	100
Typical minimum thickness	1-2 μm	10 μm	10 μm

5. Indicate four types of polarizations for dielectric materials and explain their mechanism. (20%)